

PANTEX ENVIRONMENTAL RESTORATION

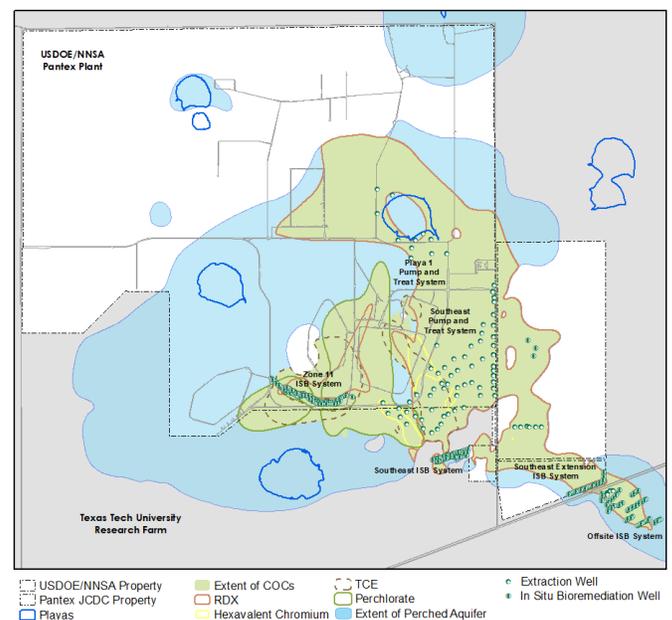


In Situ Groundwater Bioremediation Systems

The Pantex Groundwater Resource Conservation and Recovery Act Facility Investigation Report identified impacts to perched groundwater that require corrective action. The Pantex Site Wide Human Health Risk Assessment found that perched groundwater underneath the Pantex Plant contains high explosives and other constituents that could migrate over time to the Ogallala Aquifer, the main drinking water source for the area. A Record of Decision (ROD) was issued in 2008 with concurrence of the Environmental Protection Agency (EPA) and Texas Commission on Environmental Quality (TCEQ) to address cleanup of the legacy contamination at the Pantex Plant. The Selected Remedy for perched groundwater is a combination of extraction and treatment in areas with greater than 15 feet of saturation and in situ treatment in the thinner areas.

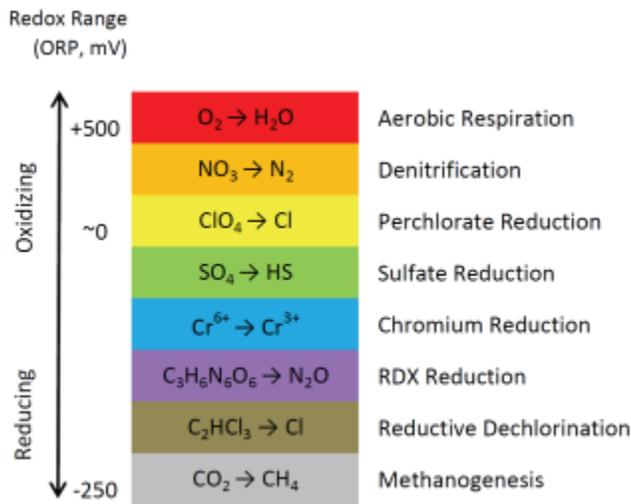
The area of primary concern for in situ treatment is in the area southeast of the main Plant on the adjacent Texas Tech University property. The fine-grained zone prevents vertical migration in most areas, but becomes thinner and more permeable in the southeast, so migration to the Ogallala Aquifer is more probable there. The area to the southeast also has thin saturated thickness so pump and treat technology is not a viable option in portions of that area. Another area to the southeast was identified after the first Five-Year Review where it was noted that the area was not under control of the pump and treat system and the high explosive plume was continuing to migrate to the southeast. Another area identified for cleanup is located south of Zone 11 on Pantex property and is a concern for migration offsite to the Texas Tech University property.

To address the areas of concern, Pantex operates four in situ bioremediation (ISB) systems currently consisting of 230 injection wells and 18 downgradient wells to monitor the effectiveness of the treatment zone. The Southeast ISB was installed in the southeast area of the plume on Texas Tech property where the fine-grained zone is more permeable. The Southeast ISB Extension was installed at the southeast property boundary east of FM 2373 to prevent further offsite movement of the perched groundwater plumes. The Offsite ISB began installation in 2020 to cleanup plumes that have moved offsite. The Zone 11 ISB was installed to intercept contaminants moving towards Texas Tech University property to the south and to address multiple contaminants that are treatable with ISB technology.



Plume Boundary and Groundwater Remedies, 2022

The objective of the ISB systems is to establish an anaerobic biodegradation treatment zone capable of reducing contaminants to levels that are safe for residential use. This is accomplished by injecting the necessary amendments or nutrients into the treatment zone wells to stimulate resident bacteria. As the naturally occurring bacteria feed and multiply, oxygen is removed from the injected area and deep reducing conditions are established for treatment of the contaminants. The ISB must achieve reducing conditions for perchlorate, chromium, RDX, and reductive dechlorination (TCE). The figure below shows the reducing conditions required to breakdown various contaminants.



Pantex monitors the treatment zone to evaluate the health of the bacteria so injection frequencies and volume of food source can be adjusted. Downgradient wells are also monitored to evaluate the effectiveness of treatment. As long as optimal subsurface reducing conditions and a food source is available, a diverse bacterial community can be sustained which leads to in situ treatment of contaminants.

The Southeast ISB system was installed in 2007 on the Texas Tech University property, as an early action. The injection wells were drilled in a line perpendicular to the hydraulic gradient so the water flowing through the treatment zone will be treated before reaching the area beneath Texas Tech property where the fine-grained zone layer becomes thinner and more permeable.



Amendment Tanks and Control Buildings at the ISBs

This system has been significantly impacted by the dewatering operations by the pump and treat systems and only one more injection may be required to complete treatment of the remaining water in the system. Pantex will continue to monitor to determine whether further injections are necessary.

The Southeast ISB Extension was installed in 2017 after discovery of the high explosive plume expansion beyond the property boundary. The system was designed to prevent further movement of the groundwater plume offsite in areas that are not captured by the pump and treat system and water saturation is too thin to pump. Based on the rate of perched groundwater flow and estimated longevity of molasses, injections are necessary every 6-9 months.

The Offsite ISB installation began in 2020, with further phases of installations through 2023. System components will be operated as they are installed. This system will treat HE contaminants that have moved offsite in thinner areas of perched saturation. This system is planned for molasses injection twice annually.

The Zone 11 ISB system was installed in 2009 as part of the final remedy with multiple expansions occurring as the plumes have changed direction due to the removal of water by the pump and treat systems. The latest phase of installation occurred in 2021 to address the

changing groundwater flow. The injection wells were installed so water flowing through this zone will be treated before it reaches the area south on Texas Tech property near Playa 4. Based on the rate of perched groundwater flow and estimated longevity of molasses, injections are necessary every 9-12 months.

The Southeast ISB primarily treats the high explosive RDX and hexavalent chromium. This system has successfully treated high explosives and hexavalent chromium below safe levels at most downgradient wells. One downgradient well on the southwest end of the system does not demonstrate treatment. Pantex is investigating whether this well is hydraulically connected to the system or if treatment has not been effective in a portion of the system. Pantex has attempted to better distribute amendment by using diluted molasses as the amendment and increasing the volume injected in each well. Due to the decrease in water levels for the operation of the pump and treat system, this system is near the end of injections. An injection event was completed in 2022 for this system and future injections will only be performed as indicated by monitoring data.

The Southeast ISB Extension primarily treats the high explosive RDX and 4-amino-2,6-dinitrotoluene (a breakdown of the high explosive TNT). The system was injected in 2020, 2021 and 2022. Injections for the system are necessary every 9 months. Treatment effects are beginning to be observed in downgradient wells. Treatment effects inside the ISB are have already been established.

The Zone 11 ISB primarily treats the organic solvent trichloroethene (TCE) and perchlorate. The full system was injected once in 2022. This system has successfully treated perchlorate to safe levels and TCE has been greatly reduced and is meeting safe levels through most of the ISB. Other areas are expected to meet safe levels in a short time. While TCE levels are declining, the breakdown products of TCE are just beginning to show signs of treatment.

The amendment strategy was changed in 2018 from emulsified soybean oil to a higher dosage of a more

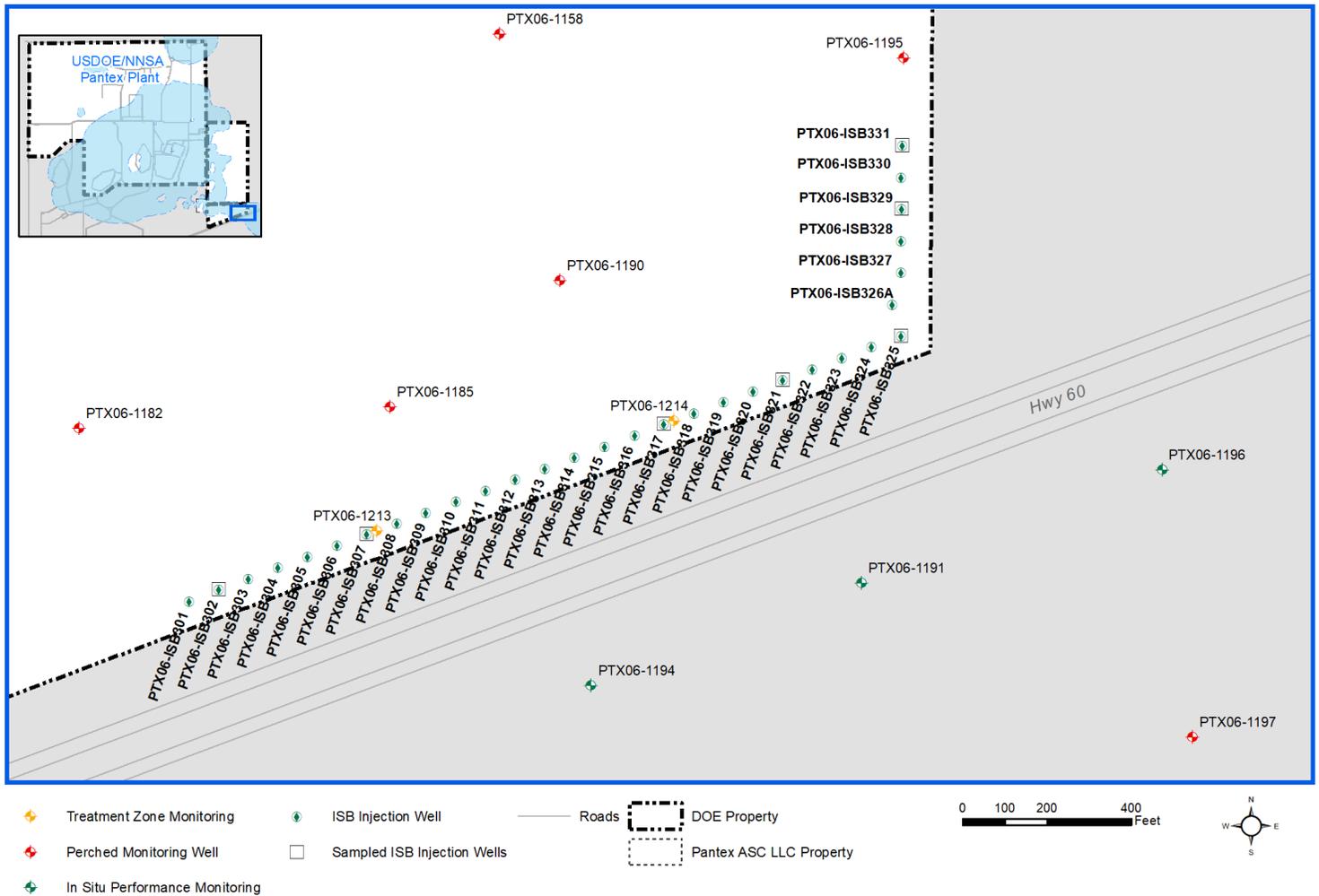
soluble carbon source (molasses) to provide better distribution of the amendment throughout the zone. It is expected that the change in amendment distribution will completely treat TCE and its breakdown products to safe drinking levels. Pantex added new wells in 2021 with closer spacing to allow for injection with emulsified vegetable oil, a longer lasting amendment. Those wells will only require reinjection every 3 to 5 years.

To address HE contamination that moved onto a neighboring property, Pantex began installing an Offsite ISB system in 2020. This ISB is located to the southeast of Pantex-owned property, south of Highway 60, and as of 2023, consists of 62 ISB injection wells and 53 extraction wells. Installation of additional wells and infrastructure continued thru 2023. Based on the use of molasses, injections are planned every six months at differing parts of the system. Injection plans will follow the schedule that was designed using fate and transport modeling and optimization modeling. Initial construction began in 2020 and into 2021. Injections began in June 2021 and two more injections occurred in 2022.

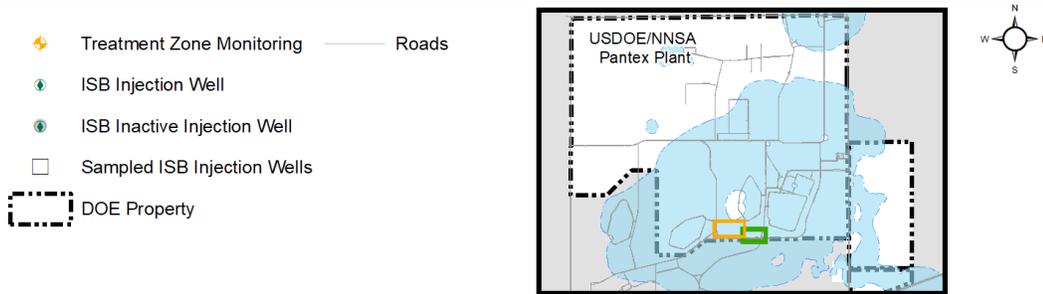
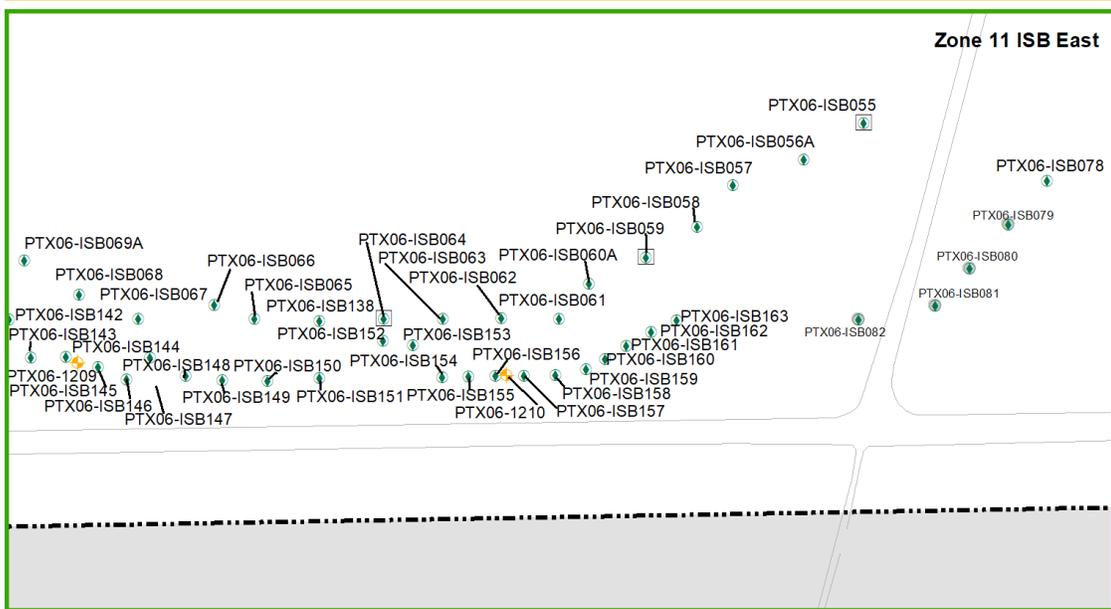
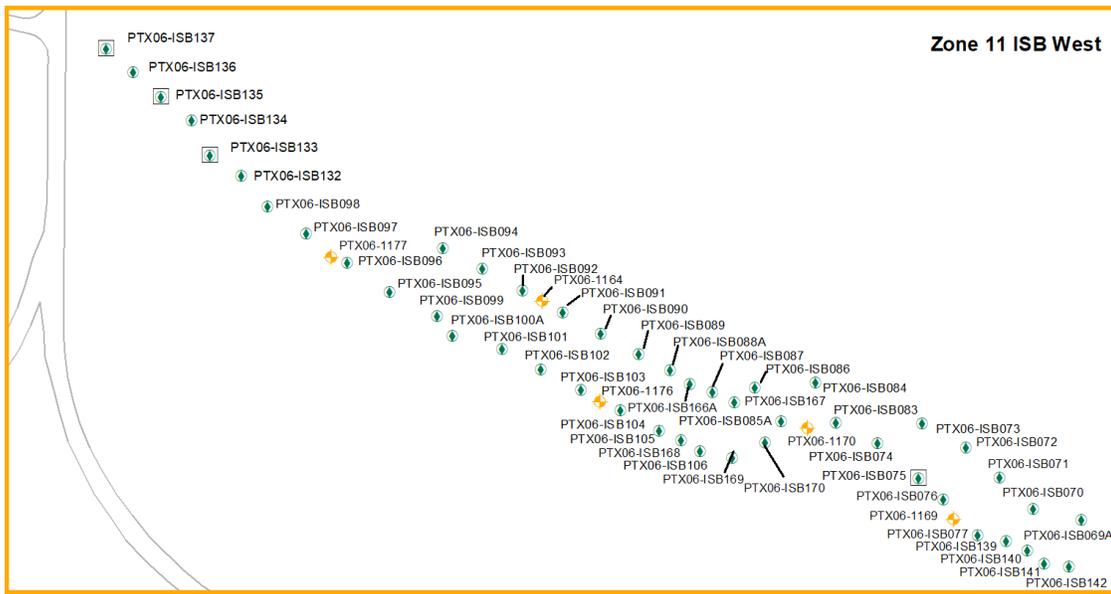
It is expected to take several years of treatment to allow the contaminant plumes to move through the treatment zones. Pantex will continue to operate this action and provide results in progress reports that can be found at pantex.energy.gov. This action is one of several positive steps Pantex is taking to protect the public and Ogallala Aquifer.



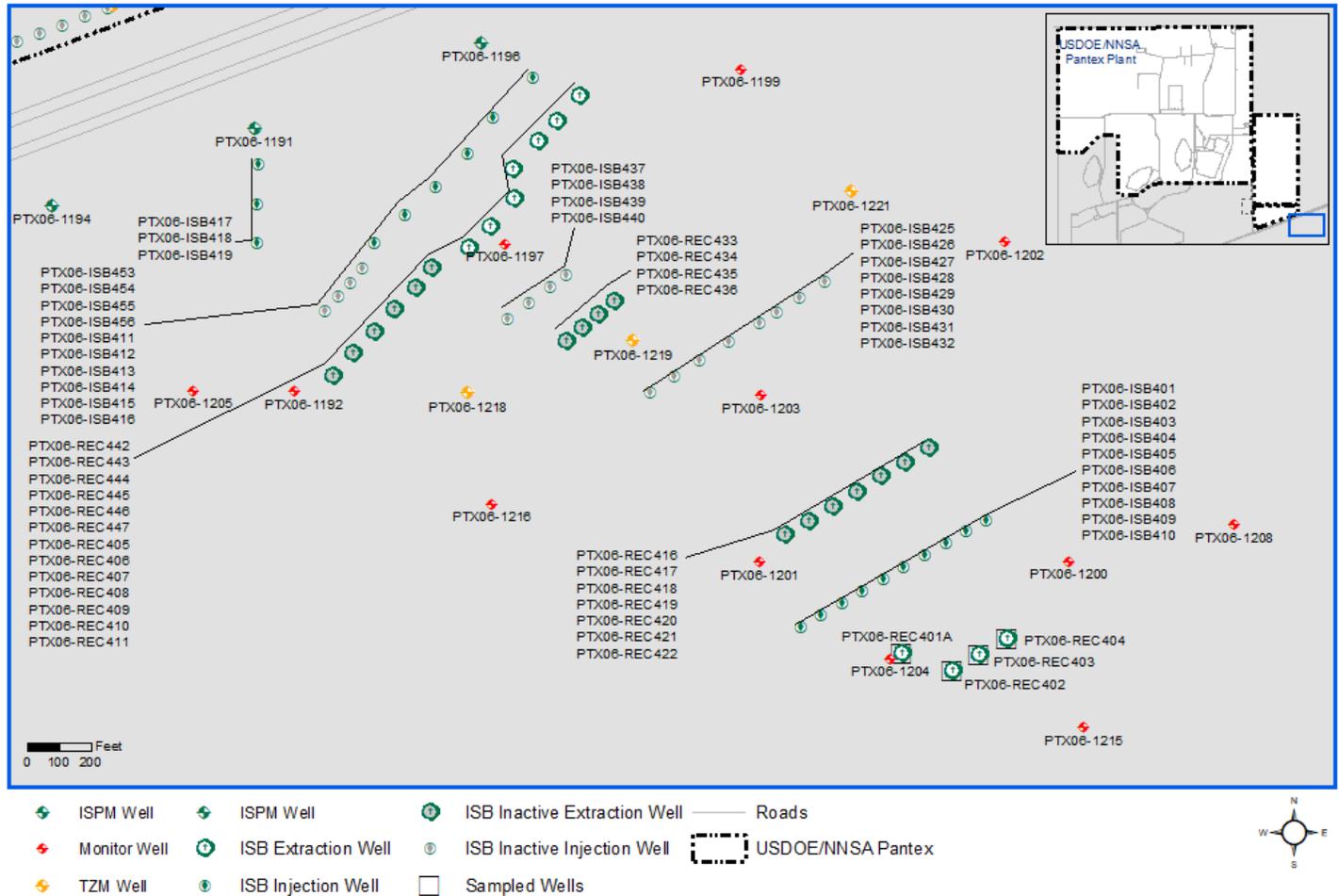
Injection Trailers at Zone 11 ISB



Southeast Extension ISB System, 2022



Zone 11 ISB System, 2022



Offsite ISB System, 2022

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